were checked by exchanging the conducting wires and lamps.

On January 20 the lights produced by the machines were tested against each other as follows, viz. :—1 Gramme *versus* No. 58 Siemens, 1 Holmes *versus* No. 1. Siemens, 1 Holmes *versus* 2 Grammes. An experiment was also made for determining the relative intensity of the light and horse-power absorbed by the Siemens No. 58 machine when running at half and full speed. With the machine running at half speed the light was found to be so unsteady that it could not be correctly measured.

The relative intensities of the light produced by the machines were as follows, viz. :—

1 Gramme *versus*	No. 58 Siemens	as 100 to 116
1 Holmes ,,	No. 1 Siemens	as 100 to 557
1 ,, ,,	2 Grammes	as 100 to 663

On a subsequent day comparative trials were made of the two small machines of Messrs. Siemens, numbered respectively 58 and 68, when the intensity of the light was found to be as 100 for 58 to 109·5 for 68, being 9·5 per cent. in favour of the latter machine.

A trial was made of the two small Siemens machines, Nos. 58 and 68, working singly, and also together in parallel circuit. The intensities were found to be as follows, viz. :—

No. 58 Siemens machine	4,446
,, 68 ,, ,, ...	65,63
For the two machines	11,009
Nos. 58 and 68 coupled together	13,179

There was thus shown to be a superiority in the intensity of the light produced by the two machines coupled together over that produced by the two machines when working singly, as 11,009 to 13,179, or as 100 to 119·7, being 19·7 per cent. more light with the two machines coupled together.

Experiments were also made for determining the relative intensities of the diffused beam of light with the carbons in the same vertical line, and of the condensed beam of light with the axis of the bottom carbon nearly in the same vertical plane as the front edge of the top carbon ; also the intensities of the side and rear light. With the latter arrangement of the carbons the intensities were as follow, viz. :—

SIEMENS MACHINE, No. 68.

	Intensity. Standard in candles.
1. Carbons with axis in same vertical line ...	2,021
2. Axis of bottom carbon in same vertical plane as front edge of top carbon. Front beam	5,804
3. Same arrangement of carbons. Side beam, 90° from No. 2	2,346
4. Same arrangement of carbons. Back beam, 180° from No. 2	772

Messrs. Siemens having submitted for trial with their machines a conducting cable of larger dimensions than the South Foreland cables, and of the length required between the engine-room and the High Lighthouse, Mr. Douglass made some experiments with it in connection with each machine. The cable was 1,400 feet in length, and composed of 19 copper wires of No. 16 B.W. gauge well insulated. The cable was cut into two equal lengths of 700 feet each, and arranged in two coils in the engine-room. The currents from the Nos. 58 and 68 Siemens machines, separately and collectively, were sent through it to the electric lamp, which was also placed in the engine-room, and at a distance of 100 feet from the 6-wick oil test lamp. The short current to the lamp was made through 22 feet of the small cable of Messrs. Siemens, composed of seven copper wires of No. 13 B.W. gauge. The loss of light with the machines was found to be as follows, viz. :—

	Per cent. of the whole light.
No. 58 machine	24
No. 68 ,, ...	23
Nos. 58 and 68 coupled	35

The experiment previously referred to with the Siemens machine No. 58 showed a loss of light of about 43·8 per cent. with the current sent through 700 feet of the small lighthouse conducting cable. There would therefore appear to be a reduction in this loss of 43·8 less 24 = 19·8 per cent. by adopting the larger cable.

The results of these interesting and carefully-conducted experiments are entirely in favour of the small Siemens machine, which both Dr. Tyndall and Mr. Douglass recommend for adoption at the Lizard.

THE MOVEMENTS OF A SUBMERGED AQUATIC PLANT[1]

FOR a long time the researches of Dutrochet and Payer, taken up and continued by Duchartre, Sachs, and others, have familiarised botanists with the movements of torsion or of flexion presented by certain plants. Notwithstanding these conscientious researches this question is still one of the most mysterious problems in vegetable physiology. I propose to draw the attention of biologists to a fact of the same kind, which I believe new, and which is connected with the phenomena observed in phanerogamous aquatic plants, living entirely submerged. It relates to a well-known aquatic plant, *Ceratophyllum demersum*, which must be included among the number of those which, in certain of their parts, and at certain periods, spontaneously execute regular movements subject in their range to a well-marked periodicity.

It is known that the Ceratophyllum grows in the still water of ponds, and that its slender, branching, floating stems bear whorled leaves. Their ordinary position in stagnant waters is vertical, or nearly so. It is in the upper part of these stems (of those at least whose whorls are separated by about one or two centimetres) that these movements show themselves. They consist in the regular bending and straightening of the axis or of the branches, combined with a torsion more or less pronounced.

Taking the axis at its maximum of erection, it is seen to bend regularly, and with the peculiarities I shall indicate immediately, to curve more and more for about six hours, when it reaches its maximum of flexion ; then straightening itself more gently, in twelve hours it resumes its original position ; it next bends in the direction opposite to its first flexion, and in four hours it attains its maximum of inverse deviation, resuming its first position in four hours more.

Thus a young branch is vertical at 6 A.M., at its maximum of inclination at midday, perfectly straight again at midnight, inclined at the maximum towards the south at 4 A.M., vertical again at 8 A.M, at its maximum of inclination to the north at 2 P.M., quite erect at 2 A.M., inclined at the maximum to the south at 6 A.M., vertical at 10 A.M., and so on.

The total duration of an evolution will thus be about twenty-six hours. These oscillations, although nearly equal in duration, do not present at all ages of the plant the same extent nor the same amplitude. At first not well marked, but involving the entire axis, they become more and more pronounced with the age of the branch ; then the lower internodes become successively immobile, and the terminal ones alone continue to move.

The branches of the Ceratophyllum present two different aspects. Sometimes the whorls are very close to each other, the internodes being very short ; the leaves of the consecutive whorls, resting on each other, make with the stem a very acute angle and form a compact mass. Sometimes the internodes are elongated, the whorls are

[1] From an article in *La Nature*, by E. Rodier.

separate, the leaves gradually extend, forming with the axis a greater and greater angle, and some finish by turning themselves down towards the base of the branch.

It is under the last form that the plant accomplishes, in the most apparent manner, the movements to which we refer. These become more manifest when young branches grown in an aquarium assume, in consequence, a slender and weak aspect, and the leaves become almost capillary. Consequently the best manner of observing and measuring the oscillations consists in submerging a piece of the stem bearing an axillary bud, and fixing the fragment by means of a weight. The young branch then assumes a vertical position, and its movements soon make themselves apparent. It is then easy to see that the movement of flexion is produced first in the superior internodes, and that it is propagated thence in a diminishing degree from above downwards; while, on the contrary, the movement of erection commences with the inferior part terminating with the superior, which sometimes, shortly before quite recovering itself, forms with the axis a very acute angle.

The oscillations continue very apparent during several days; ordinarily they diminish at the end of a certain time. Their amplitude decreases, and the branch becomes motionless or apparently so. But after thus remaining stationary it may resume its former variations. There are, moreover, branches, especially those which are almost horizontal, which continue motionless.

Light does not appear to have any influence on these movements. At least the suppression, the diminution, the change of colour, or the direction of the luminous rays have not had any apparent influence on them. Although I have seen the leaves participate in the movements of the axis, the modifications they have undergone may well be mechanically produced by the inflexions of the axis itself.

As to the movement of torsion, I am not able to say anything precise for want of experiments sufficiently con-

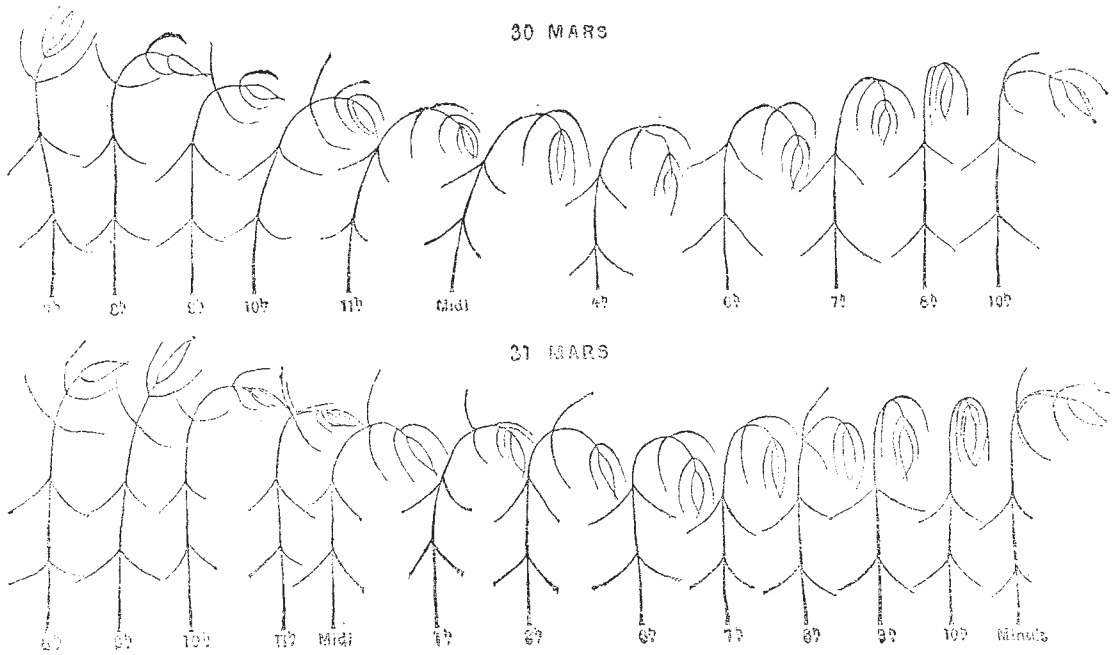

FIG. 1.—Various positions assumed by a branch of *Ceratophyllum demersum*.

clusive. The movement is nevertheless very apparent. It takes place sometimes in one direction, sometimes, and much more energetically in another. By means of an index made of a thin plate of mica or glass, supported by a small glass float sufficiently weighted, the whole resting on one of the whorls, and carefully turned round by means of a pin moving over a scale, I have measured angles of tension of 35 degrees in nine hours, 120 degrees in seven hours, 450 degrees in nine hours, &c. But having only lately commenced the research, I must abstain from co-ordinating the results.

Such are the general facts which I have to indicate, and in support of which I give an illustration of particular cases. The figure gives for a branch nineteen positions for March 30 and 31 and April 1. The very marked movements took place from north-east to south-west, and the entire evolution in twenty-six hours.

The priority of action of the superior internodes for the flexion, and that of the inferior internodes for the erection, is here very evident. The nutant attitude of the apex of the shoot, almost at the moment of complete erection, is also extremely striking.

To April 26 the movements continued, but they were then limited to the superior extremity of the branch. It appeared to shrink from the light, but as at the same time a branch in close proximity turned towards the light, the direction of displacement could not be so accounted for. I, nevertheless, during the following days (1) totally suppressed the light, (2) threw light upon the plant, by means of a mirror, in a direction opposite to that of the ordinary light, (3) placed a screen reaching almost to the middle of the plant, (4) placed in the path of the rays a red glass, intercepting as far as possible the other rays. The phenomena remained the same.

NOTES

THE Queen has conferred the honour of the Companionship of the Civil Division of the Order of the Bath on Prof. Frederick Augustus Abel, F.R.S., Chemist to the War Department and President of the Chemical Society, and on Major-General Charles Wright Younghusband, F.R.S., R.A., Superintendent of the Royal Gun Factories.

THE University of Cambridge proposes to confer the degree of LL.D. upon Mr. Charles Darwin.